Tunneling and Electron Properties

Ilgaitis Prūsis[1], Peteris Prūsis[2]

Abstract

Tunneling is a quantum mechanical phenomenon when an electron is able to penetrate through a potential energy barrier that is higher in energy than the particle's kinetic energy. The tunnel effect in contemporary physics is explained by the wavefunctions that can penetrate through a potential barrier. The article presents another view that the tunnel effect is caused by fluctuations of electrons in the Zitterbewegung.

Keywords: physics, space, gravitation, electricity, magnetism, nuclear physics, Unified Field Theory

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01.55.+b General physics; 04. General relativity and gravitation; 03.50.-z Classical field theories; 12.10.-g Unified field theories and models

[1] Independent researcher;

[2] Independent researcher

Introduction

Quantum tunnelling is a fascinating and fundamental phenomenon in quantum mechanics where a particle can pass through a potential energy barrier that it classically does not have enough energy to overcome. The tunnel effect has been known since 1928, when it was discovered by Friedrich Hund [1]. This effect is widely used in technology (tunnel diodes, tunnelling microscope), biology and science both to explain alpha decay of atomic nuclei and nuclear fusion in stars. In quantum mechanics (QM), the tunnelling effect is considered evidence that electrons have both wave and particle properties [2,3]. QM believes that an electron can pass through a potential barrier as a wave if the wavelength is greater than the thickness of the barrier (Fig.1).

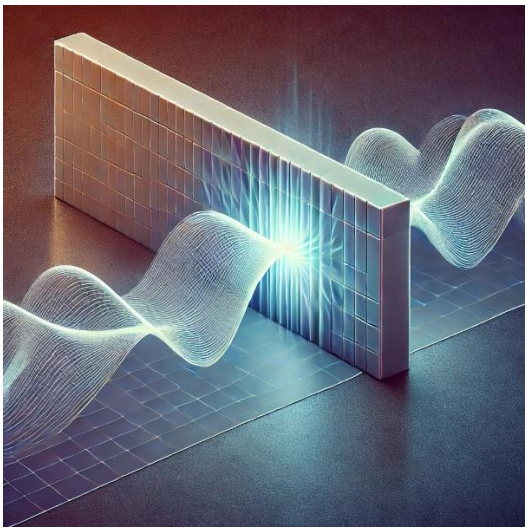

Fig.1. Quantum tunnelling as explained in quantum mechanics.

Below is shown how an electron can overcome a potential barrier if its average energy is lower.

Zitterbewegung

The electron moves along a very complex trajectory [4], which is determined by heat (thermal movement), drift (motion under the influence of an external electric field) and zitterbewegung [5,6]. To explain the tunnel effect, the main thing is the oscillations of the zitterbewegung.

The cause of the Zitterbewegung oscillations is the electromagnetic field around the electron. This is described by Maxwell's equations. As an electron moves, the

electric field in space changes. Any change in the electric field causes a corresponding magnetic field to be generated according to: $\delta \boldsymbol{E}/\delta t = c(\blacktriangledown \times \boldsymbol{B})$,

where: $\boldsymbol{E}$ – strength of electric field,

c – velocity of light,

$\boldsymbol{B}$ – strength of magnetic field,

▼ – Nabla operator.

A change in the magnetic field creates an electric field: $\delta \boldsymbol{B}/\delta t = -(\blacktriangledown \times \boldsymbol{E})$.

This creates an exotic electromagnetic field that is closely related to the electron and causes it to oscillate. At time moments when the magnetic field strength is low, the electric field can exceed the height of the potential barrier and the electron overcomes it (Fig.2.).

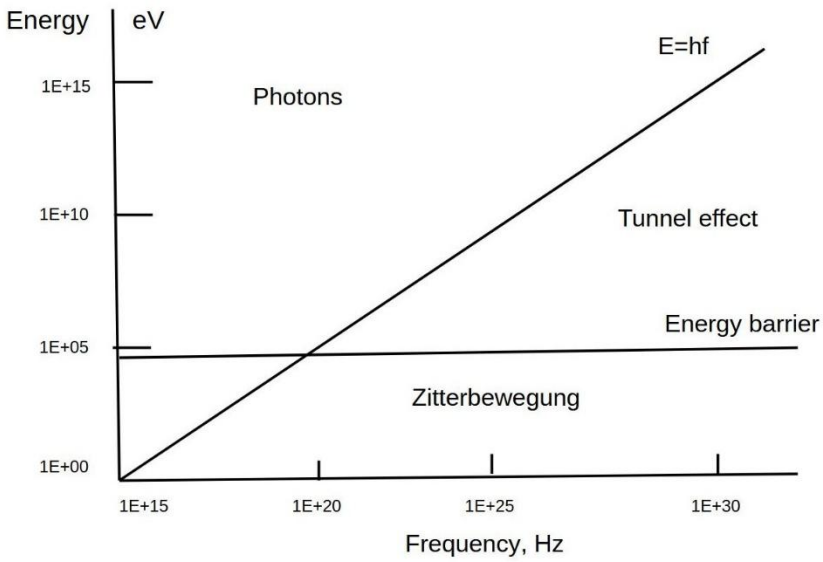

Fig.2. Electron energy taking into account the zitterbewegung oscillations

If the electron's energy is equal to or greater than the Planck's limit E=hf,
where: E – energy; h – Planck's constant; f – frequency,
then the electron emits it as a photon and there is no tunneling effect.

Conclusions

The above explanation of the tunneling effect shows that Albert Einstein was right when he said: "QM is incomplete." QM is a successful mathematical model that does not take into account the real motion of the electron. A more precise study of electron motion in the tunneling effect may reveal many previously untapped possibilities.

References

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Correspondence and requests for materials should be addressed to I.P. (ilgaitis@gmail.com).